2020「中技社科技獎學金」

2020 CTCI Foundation Science and Technology Scholarship

研究獎學金

Research Scholarship

Opto-Electronic Polymer Lab. National Taiwan University

Material Development and Characteristic Analysis in Organic Photovoltaics for Improved Stability

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Introduction

Main focus of my research is to explore promising materials by incorporating the interlayer in solar cell for green energy applications. A series of alcohol-soluble cross-linked block copolymers (BCPs) consisting of poly(*n*-butyl acrylate) (poly-(*n*BA)) and poly(N-vinyl-1,2,4-triazole) (poly(NVTri)) blocks with different individual functions and lengths are designed and high stability organic photovoltaic (OPV) cells using alcohol-soluble cross-linked poly(nBA)$_n$-*b*-poly(NVTri)$_m$ block copolymer are developed. The green poly-lysine enantiomers are revealed as electron-extraction layers (EEL) for high performance solar cells. There is a further study using poly-lysine as electron-extraction modified layer and 15%-efficiency OPVs are successfully fabricated. As the first discovery of its general applicability of the promising IFL material, poly-lysine is applied to fabricate a flexible device using 100% bio-based polyethylene furandicarboxylate (PEF) substrate and its derived OPV exhibited a PCE greater than 7% and maintained the 80% efficiency under the high bending radius of 3 mm. The present study suggests the potential application of using bio-based materials for flexible OPV applications.

Results and Discussion

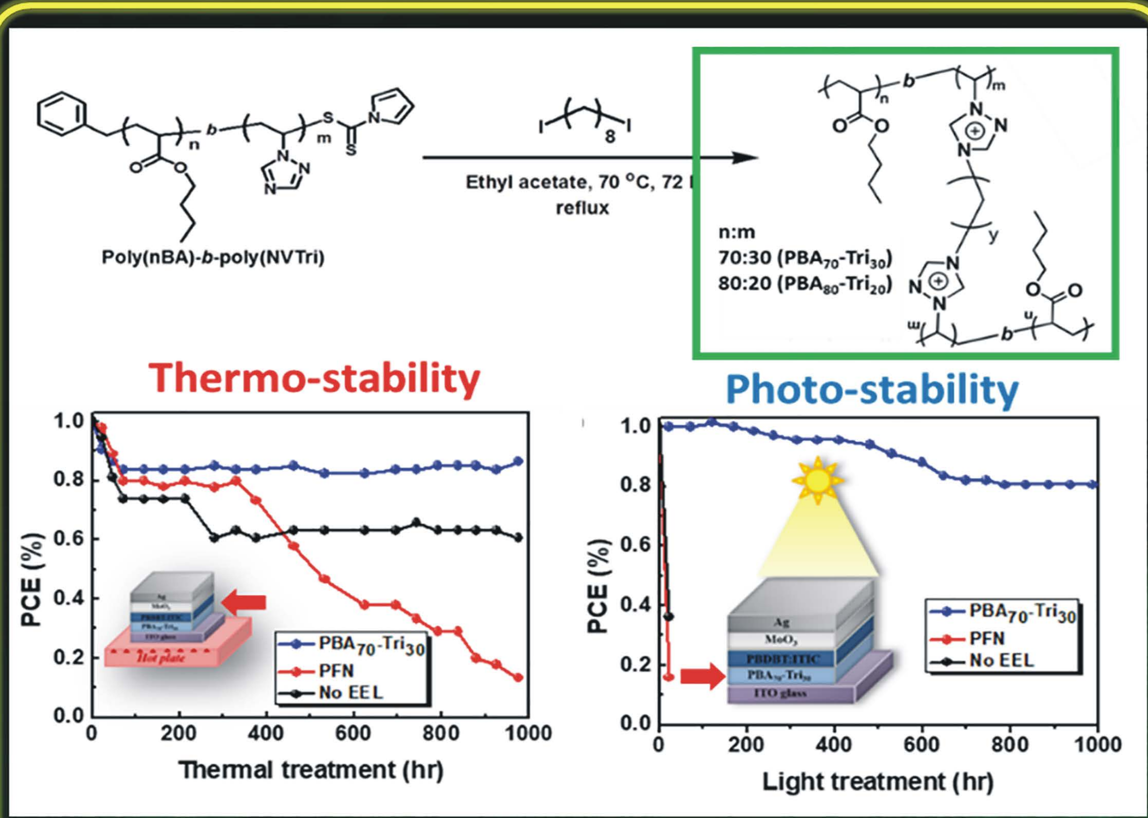

Figure 1. Thermal stability and (d) photostability of cross-linked poly(nBA)$_n$-*b*-poly(NVTri)$_m$ devices based on the PBDBT:ITIC BHJ system.

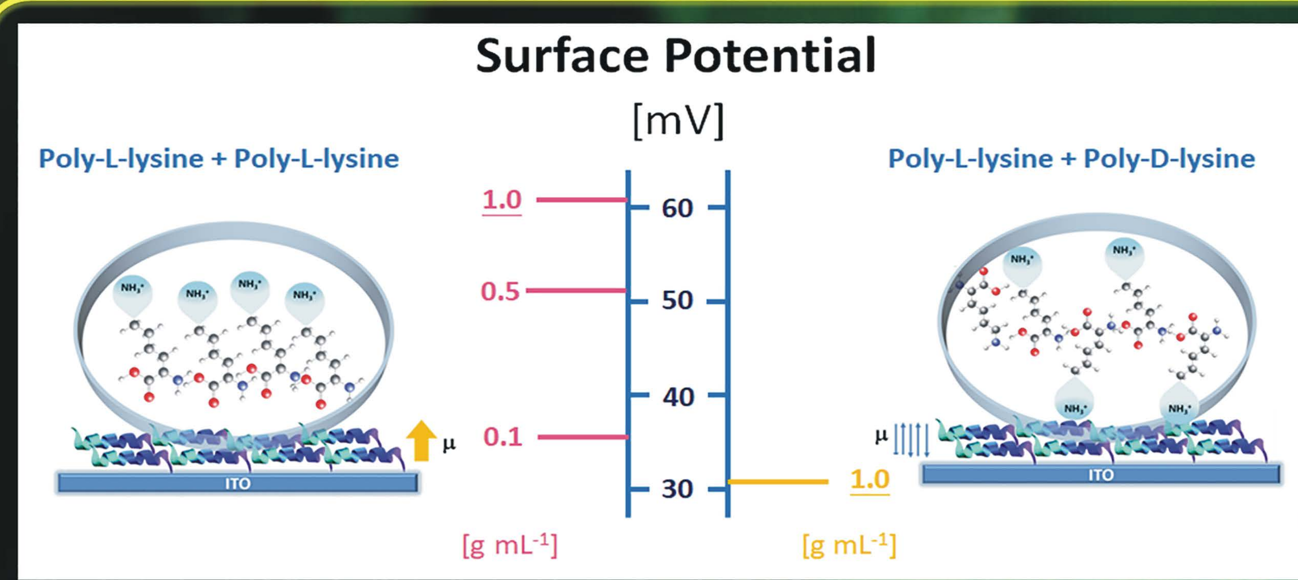

Figure 2. The surface potentials of poly-L-lysine and poly-L-lysine blend poly-D-lysine prepared in different concentrations.

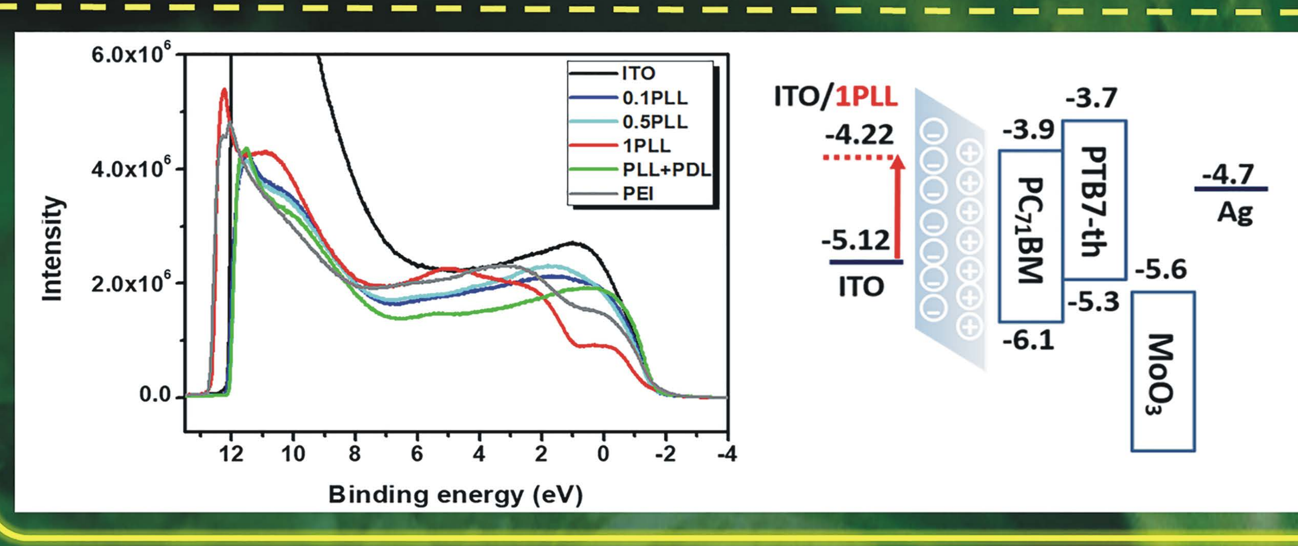

Figure 3. UPS spectra of the ITO, ITO/PLL, ITO/PLL+PDL and the energy level diagram of the OPVs based on the PTB7-th:PC$_{71}$BM BHJ system.

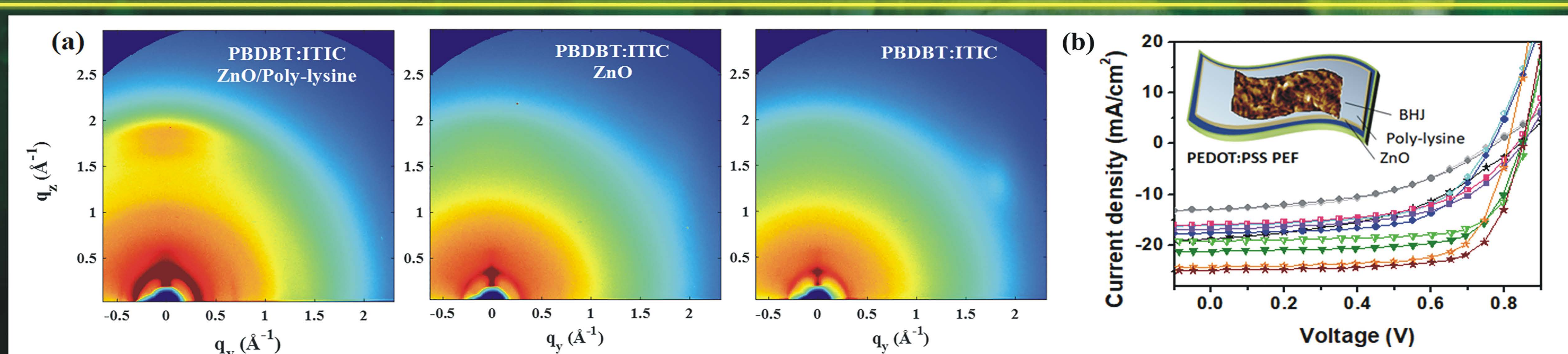

Figure 4. (a) 2D GIWAXS patterns of the PBDB-T:ITIC blend grown on different EELs. (b) J-V curve of the studied OPVs using poly-lysine as the IFL of ZnO EEL

Table 1. The photovoltaic performance of the studied OPVs using poly-lysine as the IFL of ZnO EEL.

BHJ System	Interlayer	V_{oc} (V)	J_{sc} (mA/cm^2)	FF	PCE [a] (%)
PTB7-th:PC$_{71}$BM	(ZnO)	0.76±0.01	16.02±0.08	0.59±0.02	7.18±0.07 (7.23)
	(ZnO/Poly-lysine)	0.77±0.01	17.48±0.07	0.62±0.01	8.29±0.04 (8.32)
PBDB-T:ITIC	(ZnO)	0.83±0.02	15.82±0.19	0.54±0.02	7.17±0.12 (7.21)
	(ZnO/Poly-lysine)	0.85±0.01	16.72±0.19	0.55±0.01	7.81±0.13 (7.92)
PBDB-T-2Cl:IT-4F	(ZnO)	0.86±0.01	19.01±0.20	0.70±0.09	11.48±0.13 (11.65)
	(ZnO/Poly-lysine)	0.85±0.01	20.58±0.40	0.70±0.05	12.32±0.17 (12.50)
PBDB-T-2F:Y6	(ZnO)	0.83±0.02	24.10±0.76	0.70±0.02	13.98±0.07 (14.05)
	(ZnO/Poly-lysine)	0.85±0.01	24.81±0.36	0.72±0.01	15.07±0.19 (15.31)

a) The average value is based on 12 devices. The value in parentheses is the best efficiency.

References

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